

TOPOGRAPHIC SURFACE REVERSALS AROUND A METROPOLITAN FRINGE OF BIKOKO DOUALA (CAMEROON)

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Abstract: The rapid urban sprawl along the coastal towns of some developing countries is a reflection of the increasing role of man in the management of the urban margins and its resources. Urban margins that portray a combination of difficult terrain and poverty are characterised by multiple informal activities. Individual survival and sustenance and the growing urban construction industry around Douala have propelled quarry workers to indulge in the exploitation of the coastal sedimentary rocks for sand and clay. Extensive field surveys and interviews for one decade spanning between 1997 and 2007 were conducted on most of the urban quarry sites in order to take stock of the mechanisms and impact of the activity on the urban space to the north-west of Douala. The results show that surface quarrying activity and the upgrading of wetlands have ransacked the nature of the original topography or natural landscape of the fragile littoral wetland neighbourhood around Bikoko at the outskirts of the Douala metropolis. This paper is a contribution to the anthropic geomorphology that establishes that the settlements and mining of earth resources through sand and earth excavations for land reclamation elsewhere and industrial establishments have left their ugly imprints on this littoral landscape of Cameroon.

Keywords: anthropogenesis, Douala metropolis, excavation, reclamation, topographic reversal

Introduction:

The objective of this paper has been to portray the character and enormous extent of changes produced by human manipulations in the physical conditions of the urban fringe zone or the outskirts of metropolitan Douala (Fogwe 2005). And above all, it also illustrates man's doctrinal philosophy of a powerful domination or hollow conquest of the earth (Fig. 1). As an economic beast, the

human activity on the earth's surface triggered by their quest for new economic opportunities have introduced extensive landscape modifications through sand mining, earth extraction for the reclamation of marshy landscapes and part of the Douala coastline. And through the rapid urbanisation of the extensive tracks of land around the outskirts of the Douala metropolis, man has created new landforms and landscapes over short periods of geologic time. Thus, the creation of industries in a formerly hostile marshy environment through the process of reclamation signals what future trends could be introduced by anthropogenetic geomorphology. With the alteration of the landscape at first sight, it has become necessary to ask whether this is a misuse of

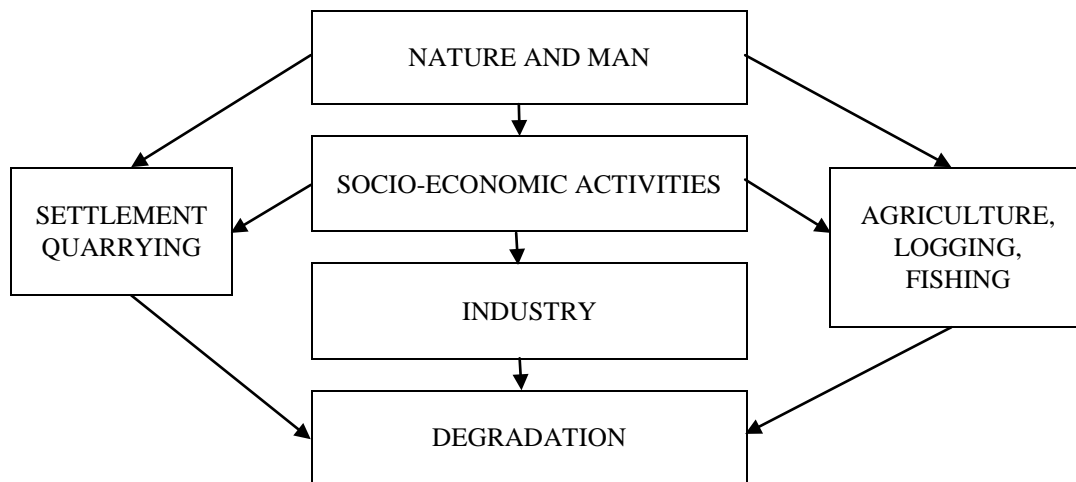
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our natural resources or whether the changes compensate for some topographic irregularities which facilitate the conquest of former “waste lands” in a heavily populated

littoral zone (Fogwe 2007) where humankind and industries are land-hungry and thus compete for this scarce resource.

Figure no. 1 Human activity and environmental degradation around Bikoko, Douala



Results and discussion:

The research problem

The study zone is an urban fringe at the north western edge of metropolitan Douala along the boundary zone between the Mungo and Wouri Divisions of the Littoral region. It spans from the Ngwele to Bikoko comprising such peripheral quarters as Ndobo, Bonenyaka and Bepele. This zone corresponds with the area of rapid urbanisation and industrialisation in a difficult physical milieu requiring important planning decisions and heavy financial inputs before building construction can be considered effective.

The soils are hydromorphic in nature permitting the growth of mangroves along the eastern banks of the River Wouri. They are formed under conditions of water saturation that is long enough to develop anaerobic conditions. The surface contains mudflats, tidal deposits and clays. These are Tertiary sandy and sandy-clay sedimentary deposits. With the thicker upper layers being

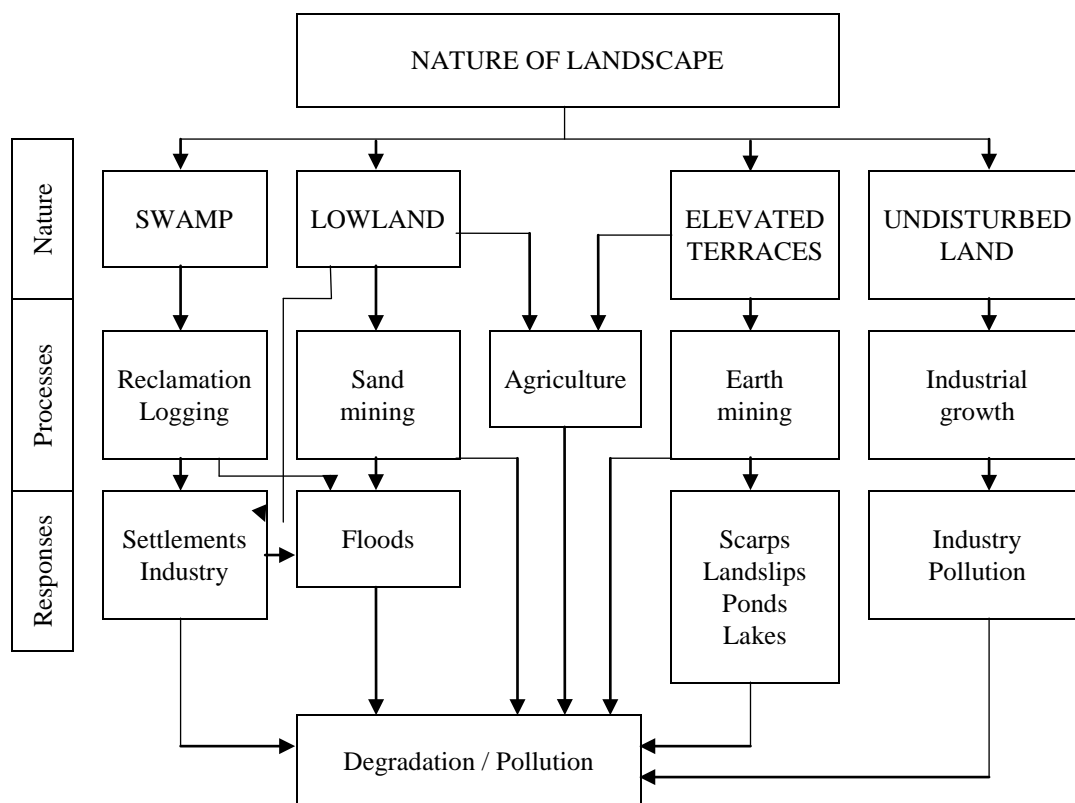
silty clays, the base is sand and gravel. There is a general inclination of the local dip of the sedimentary strata of about 5° seawards towards the Wouri River. This raises the issue whether these deposits constitute an old Wouri bed or probably a palaeo-bed or palaeo-channel. The products of the quarrying are gravel (coarse and fine grain), sand, and earth. These soil components account for the rapid increase in the landfill activities through the creation of quarries in this zone. Hence, it therefore becomes an example *par excellence* of spatial dysfunctioning of the wetland mangrove ecosystem which has fallen victim to the triple processes of uncontrolled quarrying, anarchical urbanisation and swamp land grabbing (Fig. 2).

The pattern of urban development in Douala as related to the environment makes it such that plateau areas are privileged while valley areas become “problem regions” or “areas” which suffer from waste disposal, floods (Lambi 2001), siltation, landslides, land tenure problems, temporary anarchical construction, unsuccessful indigenous

methods of flood abatement and mass movement, poor and inadequate supply of social and sound infrastructure and above all a land of no recognition. On the contrary, raised plateau areas are occupied by industries, the government and the affluent whose effluents (waste) both liquid and solid eventually end up in these very valley areas.

These hazardous zones remain at the mercy of the unknown since neither their status nor limits have been defined (Fogwe 2010). They are thus subject to sporadic government controls that quite often are aimed at evicting its occupants rather than giving them a permanent residence status.

Figure no. 2 Conceptual framework showing the Nature-Process-Response Model (NPRM)



Perhaps, it is necessary for us to understand a number of issues such as the nature of the physical constraints which necessitate the enormous financial or material inputs before construction can be made possible. These anthropogenic inputs include land reclamation through infilling and earth quarrying in the relatively elevated neighbourhoods within the vicinity. What topography does, the quarrying and land filling produce and how do these landfills modify the study area? This raises the

problems or issues which are related to the urbanisation of fragile and sensitive ecological sites which come under excessive human pressure (Hendricks - in Tank 1973).

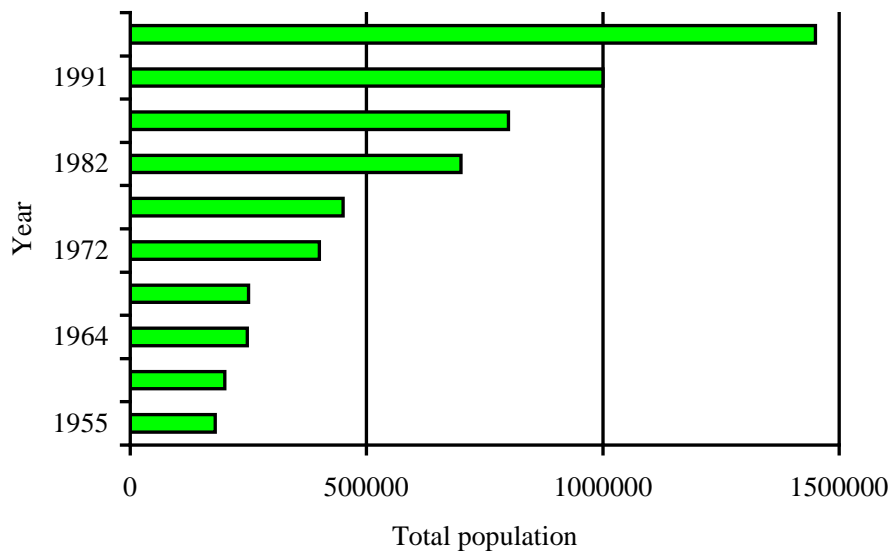
Settlement and industrial development

The population of Douala has been increasing rapidly as illustrated by Figure 3. But the periods in-between 1991-2005 and beyond have been phenomenal, thus outlining a clear image of the sheer pressure

of lots of humans and their ability to look out for somewhat “virgin” lands to conquer. It is this conquest that has introduced the nature-process-response model (Fig. 2) for this

peripheral urban fringe for the built-up areas in geomorphologically marginal and hostile landscapes.

Figure no. 3 Total population increase of Douala since 1955



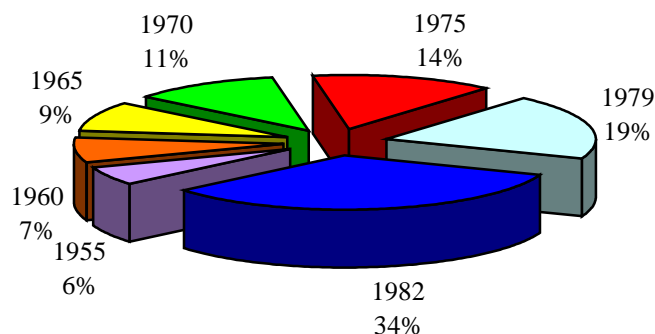
The rapidly increasing urban population since the 1980s has been responsible for the rapid urbanisation in terms of the built-up space (Tab. 1, Fig. 4 and Fig. 5).

The percentage of the built-up area has increased swiftly since the 1970s and when computed for some Key years 1970 (28.6%), 1975 (22.2%), 1979 (38.18%) and 1982 (71.05%), the percentage increases are very significant. These percentage growth rates indicate an intense human pressure on the urban landscape. This expansion was therefore the driving factor for the “colonisation” of new lands in spite of their physically hostile nature. Data from Table 1 indicate that the increases were even more dramatic between 1991 and 2005 which saw an escalation of the built-up area from 11,000 to 16,000 hectares between 1991-2000 and from 16,000 to more than 25,000 hectares in 2005.

Table no. 1 The spatial extension of Douala

Year	Area of the town (in hectares)	Percentage Increase
1960	1 450	-
1965	1 750	20.7
1970	2 250	28.6
1975	2 750	22.2
1979	3 800	38.18
1982	6 500	71.05
1986	n.a	
1987	n.a	
1988	n.a	
1989	n.a	
1990	n.a	
1991	11 000 estimate	69.23
2000	16 000 estimate	45.45
2005	25 000 estimate	56.25

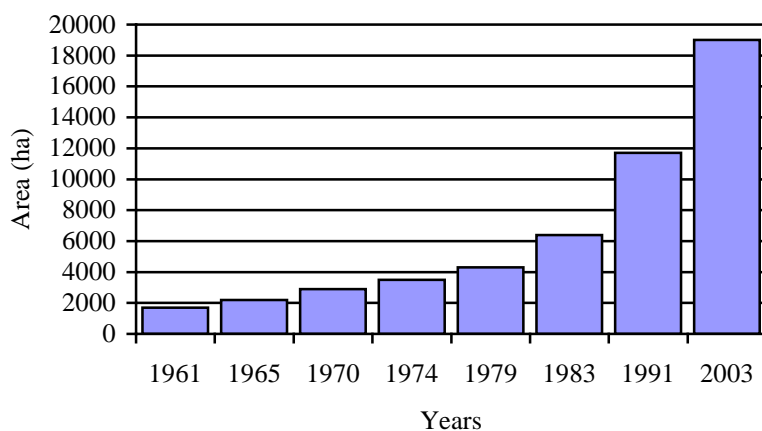
Figure no. 4 The spatial extension of Douala in hectares



Apart from the natural increase of the town itself, there has also been a rise in the number of immigrants since Douala as Cameroon’s prime city and an economic nerve centre offers better economic prospects for jobs and a good life. The total number of

immigrants rose from 22,000 in 1946 to 77,000 in 1953, 116,000 in 1960 to a total of 155,000 inhabitants. This rapidly increasing number meant that there was need to do extensive construction in order to accommodate the growing population.

Figure no. 5 The spatial size of the Douala town since independence



Such urban building activities involve the construction of houses, roads and bridges. This activity depletes the vegetation and so exposes the soil to weather elements by facilitating overland flow. It disturbs and churns the soil, and increases its erosion potential just as much as it degrades the slopes within the urban landscape and usually leaves these slopes with a disturbed soil profile as common in all soils and

landscapes with a limited vegetation cover. This building activity could also be tied to the philosophy of owning land, no matter its quality and where it is found, and probably constructing (a house or any type of building) on it. Table 2 and Figure 6 conveys the pattern of applications for land titles for houses built in Douala between 1989 and 1993.

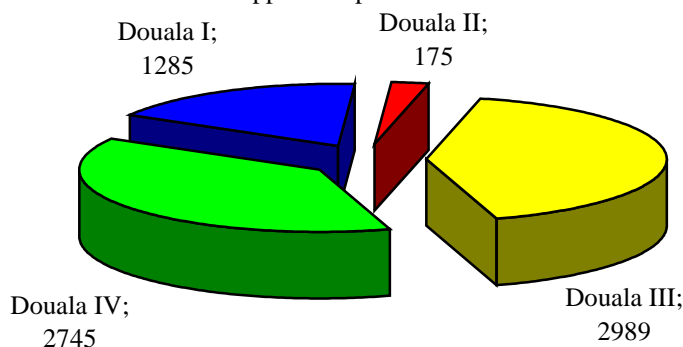
Table 2 reveals that the greatest requests for building permits came from the new or peripheral districts of the town. In this respect, the area around Ndogpassi in Douala III sent the highest number of application during these peak years and Bonaberi-Bikoko area in Douala IV. Although the total population for this Cameroonian prominent city has been increasing, the number of

applications for permits has been reducing. Although this situation seems to be a paradox, it should be remarked that most of the overflow population was finding settlement space in the peripheral zones. And so Bikoko became a favourite destination, although Bikoko was the favourite destination, and yet with what facilities and what type of physical landscape.

Table no. 2 Applications for land titles in the Subdivisions of Douala, 1989 – 1993

Years	Number of applicants per Subdivision			
	Douala I	Douala II	Douala III	Douala IV
1989	531	150	735	872
1990	102	0	291	271
1991	439	13	1612	973
1992	141	10	223	384
1993	72	2	128	245

Figure no. 6 Land title applicants per Subdivision of Douala from 1989 to 1993



It was nothing but a dominantly marginal and partially hostile landscape to which man had to introduce several modifications in order to accommodate new settlements and industrial activities. This is how the saga of the human modification of a hostile landscape has begun and evolved with the increasing population pressure since the 1990s into the Third Millennium.

Quarrying induced landscape reversal activities

Quarrying falls within the excavation group of direct anthropogenic processes of the

human agency in geomorphology (Strahler and Strahler 1973). This activity affects both the immediate and distal quarry environments. It involves an important size of the urban population considering that all its stages of transformation engender non-negligible revenue to its exploiters and users of its products. The surface exploration method is carried out on the valley slopes from where it progresses towards the relatively raised plateau, through undercutting for sand from below, while the upper part which contains less sand and gravel remains unsupported. So the

undermined upper parts therefore generally yield to the forces of gravity.

Quarrying in Douala has remained largely unnoticed and fairly neglected in spite of its wide spatial distribution. There exist numerous small sized quarries and few large ones, all of which have left an imprint on the landscape. These quarries are developed on flat or gently inclined surfaces that are then excavated to depths that vary according to the soil texture and composition. In some cases, some slope failures therefore occur as a result of the nature of exploitation. In the face of the rapid urban expansion for the past 20 years, it is certain that the demand for sand, soils and scoria would remain elastic. The profitability and potential as offered by the geographical site of Douala made quarries be created in quarters of the city such as Youpwe, Japoma (Bakoko), Ngodi (Bakoko), Bonassama, Bonamikano, Makepe II, Bonamoussadi, Kotto, Makepe Petit Pays, Airport Village and Newtown area and Bonaberi. These neighbourhoods are major terminals, which consume large volumes of the quarry products as compared to the older settlements which are located on the risk-free areas.

These urban open cast quarries portray a great variation in the surface morphology. This depends on the abundance of gravel-laden sands, stratification, neighbourhood construction, the technology employed, and the state of the activity - whether it is active or abandoned. The undercutting activity that takes place at the foot of the cliff produces a quarry platform, whereas at the edge of the platform closest to the cliff, the excavators are sometimes over-deepened. These over-deepened quarries are underlain by clay and silt form ponds during the rainy season. However, the depth of the quarry pits depends on the height of the local water table as well as the availability and abundance of the underground sand and gravel. Some quarries have a stepped surface morphology. On the abandoned cliff-like platform, the vegetation is struggling to regain its foothold. The bottom of the ponds, in the dry

season, develops polygonal cracks on the clayey deposits.

Some of these peripheral zones around Bikoko with elevated topography suffered a double tragedy. First, the elevated state meant that it had tons of earth which could be excavated for the reclamation of wetlands or for infilling within urban Douala. So tons and tons of earth were consequently moved out from parts of these peripheral zones. However, in the process of excavation, a uniformly even or level surface was never maintained. The over-deepened parts today have become artificial lakes or wetlands, some of which persist through the entire dry season.

Furthermore, we have abandoned scarps, some of which are 1.0 to 2.0 m high. Some of these collapse progressively, thus threatening adjacent built-up structures. Therefore, in providing tons of earth for reclamation and filling elsewhere, large tracks of human quarries have been permanently converted to lowlands liable to flooding as well as permanent wetlands themselves, which call for attention and some degree of infilling or reclamation, if these must be put into new land uses.

The Bikoko area has many such quarries with some that have been abandoned like those situated opposite UCB and Golden Flour companies. Each of them is about 250 m long, 200 m wide and 2 m high representing an excavated earth volume of about 10,000 m³ (Fig. 7). Some of these abandoned quarries have fully developed mangroves on their edges; some areas carry a vegetal carpet on its surface that is being exploited by cattle breeders; some quarry banks have been re-colonised by vegetation and their length ends on the walls of Golden Flour Company. The series of illustrations that follow represents the history of an anthropogenic landscape. Abandoned quarry topography portrays the initial surface marks. This reveals that several tons of earth have been quarried away for land filling or land reclamation elsewhere within the municipality.

Some of the abandoned quarry surfaces are now colonised by herbs and grasses which frequently feed the cattle brought into the town awaiting to be taken to the slaughter house within the Bonaberi neighbourhood (Fig. 8).

Figure no. 7 Abandoned earth quarries with relic landscape in the background as 1 – 2 m scarps. These quarries in a sedimentary terrain carry only sparse and less vigorous vegetation



Figure no. 8 The relic landscapes in the Bonaberi-Bikoko neighbourhood showing the relic scarps in the background of the earth quarries and overdeepened portions in the foreground making up ponds and man-made lakes



Some of the abandoned quarries also constitute the domain of vegetal growth and even small palm plantations. On the excavated surfaces only palms would grow. None of these areas have been used for the growth of any other crop because they are exhausted sedimentary soils. The backgrounds with some semi-lush vegetation indicate the permanent domain of the mangrove swamps. The upstanding small scarps render a picture of the excavations' degree which the peripheral urban fringes

suffered from the earth exploiters for urban infillings and reclamation (Fig. 9).

Perhaps, one spectacular example where man is a strong geomorphological agent is the Yato earth quarry on the eastern bank of the River Mungo. It is an extensive earth quarry measuring some 300 metres long and 100 metres wide that was opened up and tons of quarried earth were moved out from it to the Bikoko neighbourhood and elsewhere. This extensive quarry was excavated to a depth which varied from 2 metres to nearly 5.5 metres in some places giving an average

excavation depth of approximately 4.0 metres. In terms of the tonnage of earth carried out at Yato alone in a space of about three years, we take into consideration the

basic parameters of length, width and the depth of the quarry (295 x 100 x 4.0) which works out at 132,750 m³ of earth or thereabout.

Figure no. 9 The irregular excavations have given rise to flat surfaces and scarps



The excavated pits and quarries which are abandoned by the neighbouring population soon become derelict land surfaces on which household waste is dumped. In the rainy seasons, the depressions left behind following the excavations, are filled with water so that they become ponds and temporary or ephemeral lakes. But then where these excavations have been pronounced with certain over-deepened portions of the landscape, it led to the formation of lakes. This is the case of the artificial lakes around the Golden Flour Company shown in [Figure 10](#).

Their dimensions are initially determined by the size of the pits that have been abandoned, but as time progresses, there is a wash of surface material into these depressions. This considerably reduces their depths and as this process repeats itself, the depressions eventually fill up considerably to give a flat muddy surface. The overall quarry area appears to be severely damaged. Strahler and Strahler (1973) noted that the devastation produced by strip mining exceeded in quantity and intensity any of the other forms of man-made land destruction. To this immediate negative impact, it may be necessary to account that this accumulation

of clay and silt downstream helps in the fertilisation of the valley, so there is the cultivation of vegetables. Sedimentation also leads to the accumulation of debris into the estuary of the Wouri Delta. Some quarries are still being exploited and thus still supply the lateritic sand and clay and most of them are located between the banks of the River Wouri and the National road. They each feature approximately 300 m length, 200 m width and a 4 m height being 240,000 m³ of excavated earth.

Cyclical land reclamation activity

The spread of housing in wetlands and mangrove swamps has called for the systematic elimination of the mangrove vegetation through the cutting and infilling processes. In doing so, these mangroves have lost their functions as an interface between the land mass and the ocean environments. Through the poor reclamation process, man has salvaged wetlands for human occupancy through a variety of methods. But field studies from the Bikoko neighbourhood convey that the population is dependent on infilling using earth, sand, clay and other scoriaceous deposits.

While infilling progresses, the wetlands and mangrove swamps are receding. The cyclical nature of floods bears evident

testimony of the timid and unsuccessful reclamation process.

Figure no. 10 The artificial or man-made lakes near the Golden Flour Company in the Bikoko neighbourhood



The polderisation process of the Netherlands through which the land has been systematically removed from the sea in order to provide space for settlement and agriculture has been popularly acclaimed. And although man in many areas in developing countries has applied this strategy to gain new land surfaces, it has not been truly successful because the attempts are all half-baked measures predicated on the financial limits of the population and on the nature and the intensity of the prevailing climatic conditions. The methods used to backfill the swampy wetland surface in order

to put it into use either by individuals or the state include:

- filling with stream sand: sand from the River Wouri tributary streams like the Ngwele is stocked into bags and then stuffed unto the foundations as a means of reinforcing them to resist erosion and floods as well as causeways on which the house occupants move. The bags are then laid in the compound yard thus forcing the water to recede.

This method is largely applied by the population that does not have enough financial means to do the infilling,

backfilling or reclamation by the use of scoriaceous materials or earth excavated from elsewhere. Bags of variable sizes are filled and transported to the swampy areas by head load and wheel barrows. These are laid down systematically (Fig. 11).

- filling with earth: this method uses earth from the quarries which costs some 5,000 FCFA for a seven ton lorry. The earth can easily be spread and compacted and so it is highly utilised by individuals.

In those very swampy areas where humankind has completely colonised the

hostile environment, the earth filling is usually preceded by the raising of the foundations during the low flood water periods.

Active earth filling with landfill heaps is visible on the surface. Mounds are dumped and then levelled. However, with time and available financial resources, more earth is added in order to ensure that the causeways and raised portions are not inundated during floods. But this is only wishful thinking since floods remain a constant threat in these wetlands.

Figure no. 11 The reclamation process around Bikoko by the use of earth and scoriaceous deposits



Active earth filling is done in the very wet areas. Mounds of earth from lorries are then spread over the surface and this may require raising foundations in the low flood water periods. Some foundations have to be buried for more than a metre and be raised for about 1.0 - 1.5 m above the surface to be useful. This is a long-run high cost of

reversing the topography for building purposes (Fig. 12).

Figure 13 shows some causeway routes into the mangrove. Long ridges of earth being about 2 m wide are laid by hand tools to chase away water and thereby opening more access into the virgin mangrove. This penetration also serves the dual purpose of gradual and imperceptible mangrove habitat

destruction. Urban expansion is thus taking place at the expense of a natural ecosystem.

Figure no. 12 Building houses on reclaimed wetland in the Bikoko neighbourhood



- filling with gravel: this is done mostly by the big companies which eventually build heavy infrastructures that need firm soils. The material used is volcanic scoria brought into the Bikoko area from the Mount Cameroon volcanic zone of the South West Region and the Mbanga area of the Mungo Division.

This scoria is used in combination with quarried earth in order to give a perfect compaction. The earth helps to fill all the interstices between the scoriaceous deposits. It is often considered to be the overlying cover so that the underlying earth does not create a muddy surface.

Figure no. 13 Various methods of land reclamation in the Bikoko neighbourhood



- filling with solid waste: this involves industrial and household solid organic and inorganic waste that is used. Not a popular method, though, it is used by the poor and it depends largely on the availability of the waste and its rate of generation. It is the most environmentally hazardous of the methods

which should be discouraged. It is also the poorest, slow and largely ineffective reclamation process as it does not do a good job. An evaluation of the filling methods show that on the whole and in the long run, it is an unsuccessful land management technique which goes on in a cyclical

manner with no end in sight (Fig. 14, Annexes).

Conclusions:

The reclamation process is a haphazard and highly uncoordinated activity. It is, indeed, a patchwork of reclaimed and non-reclaimed areas. The colonisation of swampy areas and the mangroves constitutes a serious threat against the wetland and mangrove ecosystems and habitats. While the process to arrest land from wetlands, estuarine and mangrove environments continue, man himself within this neighbourhood is also actively creating his own wetlands. The elevated parts of the landscape which have been unthoughtfully over-excavated and over-deepened to obtain earth for reclamation inside metropolitan Douala, have left a legacy of quarries, ponds and man-made lakes. While it is necessary to do reclamation in order to provide land for settlement and industrial space, it is also necessary that the changes we must bring to a landscape should be very seriously contemplated in order to build in the sustainable factors so that the lands in question held equally significant promise for the generations that follow. The creation of industrial space and industrial parks has seen the elaborate pollution of some wetlands.

For example, the injection of pollutants of nitrogen and phosphorous compounds into the adjacent streams and wetlands account for the growth and spread of algal blooms with the consequent eutrophication of some water bodies in the area. This pollution and eutrophication around the mangroves means that aquatic life is systematically being eliminated. And apart from the assault, siege and destruction of the mangroves, which go to add to landscape degradation the aesthetic value of the landscape leaves much to be desired as we are left with the important question whether we are now altering a natural landscape and ecosystem for good or for the chaotic and haphazard development which we see on the ground. These are

environmental issues which require policy guide lines from enabled powers.

The rapid population growth remains an important problem worldwide. And the attraction given to immigrants by many prime cities is also a fact of the day. And given the fact that most migrants in cities would go to the cheap peripheral lands which have affordable prices, it is necessary for proper legislation to target a holistic development of such marginal lands.

The Dutch alluded to it and the Netherlands today with its elaborate polderisation systems remain a classic world example of how man can fight nature to conquer land for more people and more food. The way the Cameroonian sporadic, poor and half-baked reclamation measures go would only provide living as well as industrial space for a much lower number of people and fewer industries. As an incomplete process, it means that the reclamation remains a vicious cycle and goes to tell only one story, namely, that the whole process was spontaneous and was never planned to meet with the future challenges that development would bring. The vicious cyclical reclamation of the wetlands and physically hostile landscapes is a hallmark of either poor planning or the complete lack of any degree of planning whatsoever. As we look forward into the future, we should plan effectively to address the problems and challenges which our current development endeavours instils.

Rezumat:

SCHIMBĂRI ALE
TOPOGRAFIEI TERENULUI
ÎN ZONA LIMITROFĂ
METROPOLITANĂ BIKOKO DOUALA
(CAMERUN)

Expansiunea urbană rapidă în zona orașelor de coastă din unele țări în dezvoltare este o reflexie a rolului crescând al omului privind managementul și resursele urbane limitrofe. Limitele urbane, care se conturează pe

combinarea dintre terenuri improprii și sărăcie, sunt caracterizate de multiple activități informale. Asigurarea unor condiții de viață decente, precum și dezvoltarea construcțiilor urbane industriale în zona Douala, au determinat muncitorii minieri să lucreze la exploatarea rocilor sedimentare de coastă pentru nisip și argilă. Ample sondaje și interviuri cuprinse între 1997 și 2007 au fost desfășurate în majoritatea zonelor miniere cu scopul de a aduna date privind mecanismele și impactul activităților antropice asupra spațiului urban la nord-vest de Douala. Rezultatele arată că desfășoară activităților miniere pe anumite terenuri și modernizarea zonelor umede au modificat aspectul original natural al peisajului în împrejurimile litoralului din vecinătatea Bikoko, la periferia metropolei Douala. Această lucrare este o contribuție în domeniul geomorfologiei antropice, precizând că șantierele și mineritul resurselor pământului prin excavarea de nisip și pământ pentru realizarea de îmbunătățiri funciare și construcții industriale, au lăsat amprenta lor urâtă asupra zonei litorale a Camerunului.

Annexes:

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Figure no. 14 The Vicious Cycle Model of Surface Reclamation Transformation in the Bikoko Neighbourhood in the Douala Metropolis

